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Analysis of the Electricity Consumption in the South - East Geopolitical Region of Nigeria

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Abstract

The continuous electricity supply problems in Nigeria has been extensively linked to the inability of energy and urban planners to accurately forecast the effect of the various socio-economic and physical factors that influence the electricity consumption rate across the various geopolitical regions of the country. This study therefore is aimed at analysing the electricity consumption pattern in the south- east geopolitical region of the country as well as determines the influence of the socio-economic and physical features of the various states in this geopolitical region on electricity consumption. Data for the study was collected through secondary sources and covered a time frame of 21 years. Twelve socio-economic and physical determinants were identified and used in the study. This study revealed that electricity consumption in the region is not affected by sectoral consumption usage (residential, commercial and residential) in the region, Again, it was revealed in the study that the region has States of high and low electricity consumption rate. Another revelation was that the consumption rate in the region is significantly related to the socio-economic and physical features of the region. The resultant specification model for determining the influence of the socio-economic and physical features on electricity consumption pattern in the region was also formulated. Adoption of the comprehensive model of this study for predicting electricity consumption in the region was recommended to policy planners.

Keywords: electricity, analysis, consumption

1. Introduction

The Nigerian electricity industry overtime, especially since the 1990s, has been bedeviled by so much inefficiency. Iwayemi, (1992) and Adegoke (1992) have defined this period as a period of serious electricity crisis, an undesirable turning point, a time of difficulty and distress, a state of confusion when things no longer happen in the normal or usual manner. This situation which is rather pathetic has tended to explain the gravity of the electricity crisis in the country. Currently, the demand for electricity has continued to outstrip its capacity, the end result has been the delivery of poor and shoddy services, evidenced by frequent power failure. Electricity consumption in Nigeria, has been growing at a very rapid rate over the decades. Between 1970-2004, consumption of electricity in the country increased from 752 million kwh to 8576.3 million kwh (C.B.N, 2006). Given the current trends in population growth, industrialization, urbanization, modernization and income growth, electricity consumption is expected to increase substantially in the coming decades as well. All these require matching supply of infrastructure and public service to ensure sustainability. Adequate supply and distribution of electricity constitute a central development issue which cannot be over-emphasized.

Nigeria has witnessed perennial electricity crisis over the years and this has been evident by the incessant power failure and load shedding prevalent in the country. Various authorities (NEPANews, 2002; Simpson (1992); Lee and Anas (1991) have attributed the problem in Nigeria electricity sector to vandalism of electrical installations, poor funding of the industry, old and insufficient installations, low tariffs, water level fluctuations, stream flow variability and huge debts owed the electricity industry. However, the federal government in an attempt to solve these problems has increased the number of power generating plants from three in 1978 to nine in 1998 in order to eliminate the problem of water level fluctuation and stream flow variability characterized with the hydro thermal power. Six of these generating plants being thermally driven are Sapele, Delta, Afam, Lagos, Ijora and Ukpai thermal stations. Furthermore, there has been continuous increase in the budget allocation given to the electricity industry (Newswatch, 2005), and the government has imported many power transformers, circuit breakers and high tension cables (C.B.N. 2002). All these have not adequately improved the electricity crisis experienced across the country. Hence, the persistent electricity crisis situation prevalent in the country can be attributed to wrong determination and inaccurate predictions made concerning the causes of the problem, most of which are based on speculations and are devoid of any empirical backing. This unfortunate situation has largely contributed to persistent epileptic power supply in spite of the efforts made. Furthermore, this problems can be attributable to the inability of energy and urban planners to accurately forecast the influence of the determinants of electricity consumption patterns especially from its regional perspective. There is virtually absence of empirical research on geographical variations on electricity consumption considering the socio-economic and physical peculiarities of the major geographical regions of the country. This study undertakes the determination of electricity consumption pattern in the South- East geopolitical region of the country as well determine the influence of the socio-economic and physical features of the various states in this geopolitical region on electricity consumption pattern. Two hypotheses were posited in the study. The first sought to determine whether significant difference exists in the electricity consumption rate across the five States in this geopolitical region. The second states that the electricity consumption rate in the South East States is not significantly related to the socio-economic and physical features of the area. The scope of the study covers all the five South East States: Abia, Anambra, Ebonyi, Enugu and Imo States. There is need for electricity planning and development in the country. The study will, however, help reveal the extent to which the difference in each state's peculiar socio-economic and physical features affect its electricity usage in the South- East geopolitical region. This in essence would help determine the nature of electricity consumption pattern in the five states of the South- East geopolitical region of the country - whether high, moderate or low. The research will also help ensure sustainable planning in the country since the output from this study will give a comprehensive electricity consumption prediction and guide that will match the ever increasing speedy development in all sectors of the economy especially in the South- East geopolitical region of the country.

2. Literature Review

While determining the factors that influence electricity consumption in Taiwan, Holtedahl and Joutz (2004) stated that electricity consumption (kwh) can be expressed in general as a function of economic factors, x_t, and the stock of electrical energy-using equipment k_t

$kwh_t = f\{x_t, k_t(x_t)\}$.

They stated that these two variables have independent and interdependent impacts on electricity demand and consumption. Holtedahyl and Joutz (ibid) while modifying their model to suit developing countries believed that the level of urbanization is a reasonable proxy for electricity using equipment since cities are electrified faster than rural areas, and are on the forefront of adopting modern household appliances.

Mohammed and Bodger,(2006) while forecasting electricity consumption of New Zealand made a comparison of the reliability of three models that could be used to arrive at a more practicable electricity consumption model. These models include; Logistic model, Arima model and Multiple Linear Regression model. This Logistic model according to Mohammed and Bodger, (ibid) does not include many explanatory variables that are needed for a comprehensive development of the predictive factors that will determine the consumption.

For Logistic model

$$F = \frac{f}{1 + \exp(C_o + C_1 t)}$$

where;

f is the saturation value;

F is the annual consumption data;

t is time in year;

C_o and C_1 are constants

They posited that this model leads to low consumption values. Another model that was considered was the Arimah model. This model was developed by Box and Jenkins in 1970s and was well known in various aspects of time series forecasting. The shortfall of the model was that it could only be used in short term load forecasting. The model form is as follows:

$$Yt = c + \Theta_1 e_{t-1} + \Theta_2 e_{t-2} + \ldots\ldots\ldots\ldots + \Theta_p e_{t-q} + e_t$$

They concluded that this model cannot give accurate and sustainable forecast, hence it was dropped. The last model which was the Multiple Linear Regression (MLR) model was considered apt because it considers economic and demographic variables. It could also be applied in short term or long term electricity forecasting. Examples of variables used in the models are GDP, Population, Price of electricity, industries, markets, etc. The model form is

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 \ldots\ldots\ldots + b_nX_n + u$$

Where;

Y is the electricity consumption (KWh)

X_1 is the GDP (millions)

X_2 is the electricity price (cents/kWh)

X_3 is the population

u is the error (disturbance term)

They concluded by positing that this last model is all encompassing in that it provides opportunity for the researcher to know the error level and the fitness of the explanatory variables in the model. The coefficients of the independent variables are also indicated in the equation.

Arimah (1992), while undertaking a study in the spatial variation of electricity consumption in Nigeria, found out that the country was divided into two geographical zones of high and low electricity consumption. These according to him are the south-western and north eastern geographical zones of the country respectively. He highlighted that the states of the high- electricity consumption zone include: Lagos, Ogun, Oyo, Bendel, Rivers and Anambra state with Lagos state being the highest consumer. These states according to him coincided with areas of rapid urbanization, high population densities as well as high level of economic activities. He identified states of low-electricity consumption as Gongola, Niger, Kastina and Akwa Ibom. He mentioned that these areas were the least urbanized, had low population densities and had basically weak economic base when compared with those in the former group. In an attempt to also explain the variation in pattern of electricity consumption, Arimah (ibid) posited that spatial variation of electricity consumption is accounted for by difference in various regional socio-physical variables: income; the price per unit of electricity; the degree of urbanization; the population; the land area and the number of houses in the case of residential consumption: the level of commercial activity in the case of commercial consumption, the level of industrial activity in case of industrial consumption: and the distance from each state to Kanji dam.

Fisher and Kaysen (1992) suggested a two-stage model in the determination of residential electricity consumption. The consumption in the short-run (the first stage) depends on variables like Income, y_t and the price of electricity, Pe_t, and is given by the function:

$Kwh_t = u_t\, k_t = u_t\,(y_t, Pe_t)\, k_t$,

Where Kwh_t = residential electricity consumption

u_t is the utilization rate (s) of the appliance stocks.

In the second stage (the long-run), they tried to explain the factors affecting the capital stock. Their (saturation) model used the growth rate in appliance stocks, regressed on population, expected income, expected energy prices and the number of wired households. However, this model became problematic because of capital stock which works mainly by estimation.

In other to solve the problem of Fisher and Kaysen model, Harris and Lon-Mu (1993) developed an alternative time series econometric approach that avoided the use of capital stock. In this alternative approach, a distinction is made between actual consumption, kwh_t, and long-run desired or equilibrium consumption, kwh_t. The latter is affected by the level of income, relative prices and other factors. He stated that there is always a corresponding difference between equipment stock and the desired electricity consumption.

3. Methodology

Data for this study was collected through secondary sources only. The twelve socio-economic and physical factors used for this study were all measured in interval level of statistical measurement, thus, they were all parametric data. These identified secondary variables and their sources used in this study are presented below: The total electricity consumed within the study period and it serves as the dependent variable. The source of this data was National Electric Power Authority (NEPA/PHCN 2006), Lagos; other data include internally generated revenue per state in naira; Average price per unit of electricity in kobo (Defined as the ratio of total revenue to quantity consumed per state); urbanization- Percentage of the state's population living in cities with more than 20,000 people. ; population per state; Land-total land area per state (km^2) and number of households per state. Furthermore, other secondary data include number of households with electricity per state; number of major commercial banks per state; number of major markets per state: got from National Bureau of Statistics; number of major manufacturing firms (industries) per state and the distance to nearest power stations (km). This study covers a time frame of 21 years with annual time series data from 1985 to 2005. A two-way Analysis of variance (ANOVA) and Multiple Linear Regression (MLR) statistical technique were used to test first and second hypothesis respectively. In the two-way ANOVA, the dependent variable was the electricity consumption while the three major electricity consumption sectors- (residential, commercial and residential*)* as well as States are the independent variables

For the second hypothesis in which MLR was used, the equation is given as:

$$ELECON = a + b_1\,(\text{Pop Density}) + b_2\,(\text{HH elect}) + b_3\,(\text{Area}) + b_4\,(\text{Bk}) + b_5\,(\text{Urban}) + b_6\,(\text{Empl}) + b_7\,(\text{DIST}) + b_8\,(\text{IGRPA}) + b_9\,\text{Ind} + b_{10}\,(\text{Price}) + b_{11}\,(\text{HH}) + b_{12}\,(\text{Mk}) + e$$

where:

ELECON = Electricity consumption rate is the dependent variable

a = constant of regression equation

$b_{1\ldots}b_{12}$ = Regression coefficient

The independent variables in the equation include

IGRPA = Income for states- converted to per capita income

Price = price per unit of electricity in state

Urban = Degree of urbanization in state

Pop Density = Population density

Area = Land area (Density)

HH = Number of households per capita

Mk Number of Markets/state

Bk = Number of banks per capita

Ind = Number of manufacturing industry per capita

HH elect = Number of households with electricity per capita

Empl = Employment rate per capita

DIST = Distance of each state to power generating station

e = Residual error term

.4. Data presentation

Effort was made in this study to present data on the electricity consumption values for the various states in the south-east geographical region of the country over a time period of 21 years (1985-2005), as seen in table 1. Table 1 shows the consumption rate of the different States in the region. It was revealed that Anambra State has the highest consumption rate in the region, it was followed in descending order by Abia, Enugu, Imo and Ebonyi States. It is still important to note that Ebonyi State stands the least in industrial electricity consumption. This reflects a true situation because there are only few heavy industries in the State. Furthermore, the identified socio-economic/physical features of the area were presented in table 2 for clarity and brevity

Furthermore, the analysis in table 2 shows that Anambra State has the highest number of regional markets (8), employment rate (2,069,260 person), population density (534 person/hectare), households with electricity (89%) and highest number of urban areas (61.94% of the state area are urban areas) and the highest internally generated revenue in the region. The influx of people into the state accounted for this scenario. Abia State has the largest land mass as well as high number of regional market just like Anambra State in the region. The many manufacturing industries found in Anambra State may have possibly accounted for the relatively high industrial electricity consumption rate in the area as depicted in table 1. Ebonyi State has very low consumption rate (see table 1) and this could be attributed to the few number of households as well as poor assess to public power supply by only few number of households and other factors too

5. Discussions

The result of the first hypothesis suggested that there was a significant difference in the electricity consumption pattern across the five states in this geopolitical region and also across the electricity consumption sectors. The consumption rate was measured in interval data and as such a normal distribution was observed. The output of the ANOVA Levene's test which tends to assess the tenability of the homogeneity of variance shows a non-significant result (sig 0.138, $P>0.05$) and this is indicative of the assumption of ANOVA being met. The Kolmogorov-Smirnov and Shapiro-Wilk tests shows a non-significant results (sig 0.268, $P >.05$). It tells us that the distribution of the sample is not significantly different from a normal distribution (i.e. it is probably normal), and this confirms the adequacy of ANOVA as a method for testing this hypothesis.

It was revealed from the ANOVA result as seen in table 3 that there was no significant main effect of the classes of usage of electricity (residential, commercial and residential) ($P>0.05$). The F ratio is not significant indicating that the uses (sectors) upon which electricity is put significantly do not affect the aggregate consumption in the region ($P = 0.901$, $P>0.05$). In other words, if the various States in the regions are ignored, the various sectors of electricity usage do not influence the general electricity consumption. Furthermore, the result from this same table 3 shows the main effects of States. The F ratio is significant ($P = 0.033$, $P < 0.05$). What this means is that, overall, if we ignore the usage (sectors) of electricity, the States do not affect the rate at which electricity is consumed in the region. Again, and more importantly, the table shows that the interaction between the effect of States and the sectors that use electricity is highly significant. (P = 0.047, $P < 0.05$). In other words, the combination of the effects of these two independent factors has much influence in the aggregate electricity consumption in this geopolitical region of Nigeria, this is despite the fact that the one of the factor – sector using the electricity (residential, commercial and residential) does not statistically influence. Hence, the electricity consumption pattern in the area does differ across the five states in the South-East geopolitical region. The general picture painted is one which roughly divided the region into two areas of high and very low electricity consumption strata.

Similarly, Table 4 shows the subsets of the ANOVA analysis. It indicates two subsets. Further analysis indicates that Ebonyi State has the lowest mean electricity consumption (9.0033Mwh**) among** the five States. It is followed in ascending order by Imo (14.70Mwh), Enugu (16.07Mwh), Abia (17.03Mwh) and Anambra State (18.0Mwh).This is similar to the result of the study by Ubani (2011) where he observed that the electricity consumption pattern in the South South States of Nigeria's geopolitical region is divided into two areas of very high and very low electricity consumption strata. Table 1 indicates that States like Abia, Anambra, Enugu and Imo States were regarded as having high electricity consumption rate. These States have their mean annual electricity consumption values that were as high as 49MWh; Ebonyi State was observed to have a very low electricity consumption trend. Its average mean annual electricity consumption value was as low as 27.0MWh. In the same vein, the ANOVA multiple comparisons output in Table 4 shows that the mean differences in electricity consumption among the States, with the exception of Ebonyi State, other States were grouped into one subset. However, this ultimately implies that electricity consumption is not the same for the five States; rather, it differs significantly among some of them. However, Abia, Anambra, Enugu and Imo States were homogeneous.

The result of the second hypothesis suggests that the electricity consumption rate in the south-east States is significantly related to the socio-economic and physical features of the geopolitical region as seen in table 5. (R^2 = .972, Adjusted R^2 = .961, Standard Error = 0.3987, F-cal = 42.03, P-sig = 0.000, $P < 0.05$ significant level, Durbin-Watson = 1.420). This implies that these socio-economic and physical features strongly influenced the pattern of electricity consumption in region. States in the high consumption regions coincided with areas of rapid urbanization, high population densities, high internally generated revenue, high employment level and greater number of banks and industries. It was also observed that most of these independent variables have positive correlation with electricity consumption except distance and number of area of land. None of the independent variables was strongly related to each other. This finding is consistent with the true situation because states likes Abia, Anambra, Enugu and Imo States, that have cities with high number of household, high employment level, more urban centres, greater number of banks and industries are the ones that had high electricity consumption rate. See table 1 and 2 for details. It is worth noting that the Durbin-Watson value of 1.420 shows that the assumption of independent errors in the regression was met. In other words, the residuals in the model are independent.

Table 6 shows that the model is not influenced by any of the independent variables. The value of all the residuals shows that the model fits the sample data well. In addition, there was no case that had large residual, thus a absence of outliers in the model. Obviously, this table 6 gives a diagnosis of the residual statistics from the regression output. From the output, none of the values of Cook's distance was greater than 1. Weisberg (1982) posited that Cook's distance values greater than 1 raises cause for concern. The mean Central Leverage value which is used to gauge the influence of the observed value of the outcome variable over the predicted values was 0.050 which is less than 0.06 (any value more than .06 gives cause for concern. (Stevens, 1992). The Mahalanobis distance which sought to measure the distances of cases from the mean of the predictor variables shows mean value of 2.500 this poses no worry since no case was up to 11 (Lewis, 1978). This general suggests that none of the cases is influencing the regression model. Other residual analysis is seen in table 6

An attempt was made in this study to develop a model specification for determining electricity consumption rate in the South East region of the country. This was possible from the multiple regression output used to test the second hypothesis. This model which has a low residual error value + 0.3987, (see table 5) would help to achieve a focused prediction on electricity consumption rate in the South East region of the country.

The resulting model is as follows:

Electricity Consumption = - 85.55 + 0.298 (population density) + 0.015 (market) + 0.211 (Households with electricity) + 0.050 (Households) - 0.196 (Area) - 0.438 (Banks) + 0.053 (Urbanization) – 0.103 (Distance) + 0.025 (employment rate) + 0.672 (Internal Generated Revenue) + 2.91 (Industry) + 0.3987 error.

Eleven of the independent variables were significantly related with the dependent variable at 0.05 significance level as shown in table 7. Each of these coefficients attached to each predictor tells about the relationship between the electricity consumption rate and each predictor (independent variable). From the model equation, two of the variables have a negative relationship with the consumption rate and these include distance and bank. Hence, each of these coefficient values indicates to what degree each predictor affects consumption if the effects of all other predictors are held constant. A concise implication of this model was discussed below:

- **Industry (b = 2.91):** Ghaderi (2004) considered this variable – number of manufacturing industry, as having strong influence on the rate of electricity consumption. While obtaining electricity consumption function for the industries in Iran, he posited that electricity consumption is considered as function the number of industrial units. Thus, in the study, number of manufacturing industries in each state of the region was considered. The model in this study indicates that as number of manufacturing industry increases by one unit, electricity consumption rate increase by 2.91 units, in other words, an increase in the number of manufacturing industry in the region is associated with additional 291mwh consumption made. Areas with more industries will invariably need more power to run the industries; hence more electricity consumed.
- **Distance to power Station/plants (b = -0.103):** It is expected that consumption of electricity will be affected by the distance of the power plants to different cities or regions. Scholars in developed countries argued that the distance of the power plants to different cities will reduce the rate of consumption of electricity (Balabanoff, 1994; Ghaderi, 2004). Attempt was made to highlight the average distance between state capitals and functional power plants. This model indicates that as distance to functional power plants increases in the study area by one unit, electricity consumption rate reduces by 0.103units, in other words, as the distance between state capitals and functional power plants closes up, there will be an associated addition of 10.3mwh consumption made. This could be because of the reduced electricity distribution/transmitting cost. However, one would have expected that the farther away the power plants are from the state capitals, the more distributional interruptions occur, and of course, less consumption. This situation is not different from what is obtainable in developed countries. This result is in line with the finding of a similar work done for the South South region of the country where it was observed that average distance between state capitals and functional power plants as well as electricity consumption has an inverse relationship (Ubani, 2011)
- **Employment Rate (**b = 0.025): Employment rate influences the economic strength of individual and this invariably will affect the rate of purchase of electrical appliances, hence increased power consumption.(Harris, and Lon-Mu, 1993). The model in this study indicates that that as employment rate increases by one unit, electricity consumption rate increase by 0.025units, in other words, an increase in the employment rate in the region is associated with additional 25mwh consumption made. Little wonder why states like Rivers and Edo that have high employment rate consume more electricity in the study area.
- **Urbanisation (b = 0.053):** Scholars agree that urbanization influences electricity consumption. This has been extensively written about in literatures. (Dahl and Erdogan, 1994; Lariviere and La france, 1999; Holtedahl and Joutz, 2004; Arimah, 1992 etc), It was generally believed that urbanization was considered a measure of economic development and is expected to increase the consumption of electricity since urbanization also implies greater access to electricity. This model indicates that as urban areas increases in the study area by one unit, electricity consumption rate increase by 0.053units, in other words, an additional urban area in the region is associated with additional 53mwh consumption made.

- **Households with electricity (b =0.211):** The number of households with electricity has been identified in literature to influence electricity consumption. Joutz and Dave (2006), while determining the residential electricity models for Washington used the number of household with electricity as a variable. The model in this study indicates that that as the number of households with electricity increases by one unit, electricity consumption rate increase by 0.021units, in other words, an increase in the number of households with electricity in the region is associated with additional 21mwh consumption made.

- **Number of Households (b = 0.050):** Halvorsen, and Larsen (1999) posited that an increase in electricity consumption is due to an increase in the number of households, while the remainder reflects an increase in average consumption per household. They used number of households as a variable in their electricity consumption modeling in Norway. In this study, however, it was observed that the number of households as urban areas increases in the study area by one unit, electricity consumption rate increase by 0.050units, in other words, an additional number of households in the region is associated with additional 50mwh consumption made. Thus, when more households migrate or spring up in the area, the electricity consumption rate will increase likewise.

Population Density (b = 0.298): Various studies have included population density value as a variable that influences electricity consumption. Ubani (2008), Hicking (2006) and Arimah (1992) established a relationship between population density and electricity consumption. Some scholars treat population and area of the regions as separate variables. In this study, it was observed that separating it would decimate the robust variable- population density. Zhenmin (2001) and Lariviere and La france (1999) used it as population density. The study indicates that that as population density increases by one unit, electricity consumption rate increase by 0.298units, in other words, any unit increase in population density is associated with an extra 298mwh electricity consumption made in the area. This is obvious in real sense, because, as more people occupy an area, there will invariably be more demand for electricity and this increase the electricity consumption rate ultimately

6. Conclusion

This empirical study on the geographical variations on electricity consumption in the South- East geopolitical region of Nigeria observed that there was a significant difference in the consumption pattern across the States in the region, however that the various landuse sectors – Residential, industrial and commercial that use this electricity do not significantly effect the aggregate electricity consumption rate in the region.

Again, the interesting revelation from the study that calls for serious consideration by policy makers in the electricity industry as well as for urban planner is the fact that the pattern of the Nigeria electricity consumption in the South-East geographical region paints a picture of areas (States) of low and high electricity consumption rate. It has become obviously clear from the study that electricity consumption in this region was strongly and significantly influenced by eleven socio-economic and physical features of the region namely, - Internally generated revenue per state , urbanization, population per state, total land area per state (km^2), number of households, number of households with electricity, number of major commercial banks, population density per State, number of major markets, number of major manufacturing firms (industries) and the distance to nearest power stations. This knowledge will aid the policy makers in the power sector of the region to be aware of the variables to consider in their planning of the region's electricity utilization for better efficiency.

The robust and reliable formulated model in the study will ensure proper predictions for electricity consumption in the South-East region of Nigeria.

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Table 1: Mean annual electricity consumption values for each state in the region from 1985-2005 (10^6 Mwh)

States	Total consumption	Residential consumption	Industrial consumption	Commercial consumption
Abia	51.1	27.08	10.73	13.29
Anambra	54.0	28.62	11.34	14.04
Enugu	48.2	25.55	10.12	12.53
Ebonyi	27.0	14.31	5.67	7.02
Imo	44.1	23.37	9.26	11.47
Total	224.4	118.93	47.12	58.35

Source: NEPA, 2006

Table 2: Socio-economic cum physical features in the six states of the geopolitical region

STATES	POPDE	HHEL	HH	AREA	BANK	IGR	URBAN	DIS	EMPLO	IND	MKT
Abia	364	79	1034100	4900	396	138,241,341	37.75	120	1,621,778	70	6
Anambra	534	89	1083080	4865	495	74,650,000,002	61.94	44	2,069,260	171	8
Enugu	254	49	617729	7534	396	18,169,385,555	41.55	109	2,063,461	81	4
Ebonyi	152	25	400125	6400	262	826,253,106	16.8	161	1,054,322	8	3
Imo	458	95	1153498	5288	362	31,298,871,150	32.67	98	1,753,004	101	4

Source: As stated above

The abbreviations in table 2 means: IGR = Internally generated income for states- converted to per capita income (₦); URBAN = % of urbanization in state; POPDE = Population density; AREA = Land area (m^2); HH = Number of households per capita; MKT = Number of regional Markets/state; BANK = Number of commercial banks; IND = Number of manufacturing industry; HHELEC = Percentage of households with electricity; EMPLO = Employment rate per capita; DIS = Distance of each state capital to the closest functional power generating station

Table 3: Analysis of variance output table: Tests of Between-Subjects Effects

Dependent Variable: Electricity consumption

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	238.444(a)	5	47.689	3.447	.037
Intercept	16683.556	1	16683.556	1206.040	.000
States	127.444	2	63.722	4.606	.033
usage	.222	1	.222	2.016	.901
States * usage	110.778	2	55.389	4.004	.047
Error	166.000	12	13.833		
Total	17088.000	18			
Corrected Total	404.444	17			

a R Squared = .590 (Adjusted R Squared = .419)

Source: Statistical Package for the Social Sciences analysis,

Table 4: Analysis of variance multiple comparison output table: (Multiple Comparisons and subsets)

Tukey HSD[a,b]

state	N	Subset 1	Subset 2
ebonyi	3	9.0033	
imo	3		14.70
enugu	3		16.07
abia	3		17.03
anamb	3		18.0000
Sig.		1.000	.134

a. Uses Harmonic Mean Sample Size = 3.000.

b. Alpha = .05.

Table 5 : The results for hypothesis two (parameters)

R^2 = .972	F-Call = 42.03
Adjusted R^2 = .961	P = 0.000
Standard Error = 0.3987	α sig = 0.01
Durbin-Watson = 1.420	

Source: Statistical Package for the Social Sciences analysis, 2011

Table 6: Summary of the residual statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	186.7403	878.9611	573.5000	303.74855	5
Std. Predicted Value	-1.273	1.006	.000	1.000	5
Standard Error of Predicted Value	23.838	41.588	33.682	6.640	5
Adjusted Predicted Value	151.6111	855.1911	626.9918	264.93875	5
Residual	-45.45819	32.03888	.00000	26.50878	5
Std. Residual	-1.085	.764	.000	.632	5
Stud. Residual	-1.398	1.230	-.034	1.127	5
Deleted Residual	- 470.924	98.06115	-53.49179	213.42691	5
Stud. Deleted Residual	-.654	.176	-.103	3.069	5
Mahal. Distance	.784	4.089	2.500	1.237	5
Cook's Distance	.006	.070	.044	12.512	5
Centered Leverage Value	.015	.081	.050	.247	5

a Dependent Variable: Electricity Consumption

Table 7: The relationship between electricity consumption and the eleven physical socio-economic factors

Variables	Unstandardised coefficients	Standardised coefficients	T	P	α sig	Comment
Constant	-85.55		-2.132	.016	<0.05	Significant
Income for states	0.672	.172	2.423	.023	<0.05	Significant
Degree of urbanization	0.053	.153	16.882	.000	<0.01	Significant
Population density	0.298	.338	2.272	.029	<0.05	Significant
Land area	-0.196	-0.096	-2.130	.017	<0.05	Significant
Number of households	0.050	.030	3.519	.001	<0.05	Significant
Number of Markets	0.015	.067	2.761	.043	<0.05	Significant
Number of banks	-0.438	-0.138	-3.208	.004	<0.05	Significant
Number of industry	2.910	.091	3.629	.000	<0.01	Significant
Households with electricity	0.211	.020	20.544	.000	<0.01	Significant
Employment rate	0.025	.285	2.238	.038	<0.05	Significant
Distance to power station	-0.103	-0.273	-2.900	.046	<0.05	Significant

Source: Statistical Package for the Social Sciences analysis, 2011.